Acetabulum-Only Revision Total Hip Arthroplasty Is Associated With Good Functional Outcomes and Survivorship

Lim, Jun Wei; Ridley, David; Johnston, Linda R.; Clift, Benedict A.

Published in:
Journal of Arthroplasty

DOI:
10.1016/j.arth.2017.02.007

Publication date:
2017

*Title Page (with full author details)

ACETABULUM ONLY REVISION HIP ARTHROPLASTY IS ASSOCIATED WITH GOOD FUNCTIONAL OUTCOMES AND SURVIVORSHIP

Jun Wei Lim, BMSc MBChB[1]

David Ridley, BSc MSc[2]

Linda R. Johnston, RGN BN MSc [2]

Benedict A. Clift, BMSc FRCSOrtho[1]

1. Department of Orthopaedics and Trauma, Ninewells Hospital and Medical School, DD1 9SY, Dundee, United Kingdom.

2. University of Dundee, Ninewells Hospital and Medical School, DD1 9SY, Dundee, United Kingdom

Please address all correspondence to:

Dr Jun Wei LIM

BMSc (Hons) MBChB

Department of Orthopaedics and Trauma

Ninewells Hospital

DD1 9SY

Dundee, United Kingdom.

Department's Phone Number: 01382 425 576

Department's Fax Number: 01382 496 201

Email: junlim@nhs.net, jun.w.lim@gmail.com

http://dx.doi.org/10.1016/j.arth.2017.02.007

***Abstract (Structured; 250 Words Maximum)**

Abstract

Background: The coexistence of a stable femoral and a loose acetabular component may pose a clinical dilemma for the surgeon. Our study aims to compare the intermediate functional outcomes and survivorship of acetabulum only revision THA (ArTHA) with an age and gender matched total revision THA (TrTHA) group.

Methods: We retrospectively reviewed prospectively collected data on the pain, function and total Harris Hip Scores (HHS) and complication profile for ArTHA and TrTHA cohorts from our regional arthroplasty database. Kaplan-Meier survivorship, with the need for repeat revision surgery as the endpoint, was used for survival analysis.

Results: Among 538 cases, there were fewer acute medical complications in ArTHA and a similar dislocation rate for both cohorts. Preoperative HHS for pain, function and total were better in the ArTHA cohort, but only the function score reached statistical significance. No significant differences in subsequent years for all aspects of HHS, except the function score was significantly better in the ArTHA cohort at year 1. 10.0% of ArTHAs and 7.8% of TrTHAs had required rerevision. The 5-year survivorship was 90.3% (95% CI ± 2.1%) for the ArTHA cohort and 92.7% (95% CI ± 1.8%) for the TrTHA cohort ($p = 0.394$). The ArTHA with posterior approach (n=118) group had the lowest dislocation rate and the best trend of functional outcomes.

Conclusion: ArTHA can provide similar functional outcomes and dislocation rate to TrTHA, with an acceptable rerevision rate. The posterior approach in this study was not associated with a significant dislocation rate.

(247 words)

ACETABULUM ONLY REVISION HIP ARTHROPLASTY IS ASSOCIATED WITH GOOD FUNCTIONAL OUTCOMES AND SURVIVORSHIP

Abstract

Background: The coexistence of a stable femoral and a loose acetabular component may pose a clinical dilemma for the surgeon. Our study aims to compare the intermediate functional outcomes and survivorship of acetabulum only revision THA (ArTHA) with an age and gender matched total revision THA (TrTHA) group.

Methods: We retrospectively reviewed prospectively collected data on the pain, function and total Harris Hip Scores (HHS) and complication profile for ArTHA and TrTHA cohorts from our regional arthroplasty database. Kaplan-Meier survivorship, with the need for repeat revision surgery as the endpoint, was used for survival analysis.

Results: Among 538 cases, there were fewer acute medical complications in ArTHA and a similar dislocation rate for both cohorts. Preoperative HHS for pain, function and total were better in the ArTHA cohort, but only the function score reached statistical significance. No significant differences in subsequent years for all aspects of HHS, except the function score was significantly better in the ArTHA cohort at year 1. 10.0% of ArTHAs and 7.8% of TrTHAs had required rerevision. The 5-year survivorship was 90.3% (95% CI ± 2.1%) for the ArTHA cohort and 92.7% (95% CI ± 1.8%) for the TrTHA cohort ($p = 0.394$). The ArTHA with posterior approach (n=118) group had the lowest dislocation rate and the best trend of functional outcomes.

Conclusion: ArTHA can provide similar functional outcomes and dislocation rate to TrTHA, with an acceptable rerevision rate. The posterior approach in this study was not associated with a significant dislocation rate.

(247 words)

Keywords: Hip; Revision Arthroplasty; Acetabulum; Functional Outcomes; Survivorship.

Introduction

During revision hip surgery, the coexistence of a stable with a loose component may pose a clinical dilemma for the surgeon. There is some limited evidence in the literature to suggest that acetabulum only revision total hip arthroplasty (ArTHA) can be technically challenging due to the limited exposure [1]. Furthermore, it has been suggested that ArTHA is associated with a higher instability and dislocation risk due to a potential difficulty in soft tissue balancing [2], and the obvious fact that only one component can be realigned. As the rate and incidence of implant loosening can be variable, some authors further suggested that total revision total hip arthroplasty (TrTHA) with new implants can enhance the longevity of revision total hip arthroplasty (rTHA) in general [3-5].

Nonetheless, the removal of a well-fixed femoral implant can result in significant damage to the remaining bone stock, more soft tissue trauma and a longer operative time, all of which, when considering the longer term outcomes, are potentially detrimental [5]. In addition, dislocation remains a relatively common and distressing complication following rTHA [6]. Many studies have been done to determine the best approach for primary THA to reduce dislocation risk [7, 8]. However, there is no clear consensus with regard to this in rTHA [9, 10].

Based on our experience, we have not agreed with the common belief that ArTHA are associated with less good functional outcome and survivorship. In practice, it is nearly always a well fixed femoral stem with a loose acetabular component. Furthermore, we believe that both anterolateral and posterior approaches have their own merits and limitations; and the approach should be based on patient characteristics, surgeon's experience and surgeon's preference. We therefore conducted this retrospective review of our experience to evaluate the medium term functional outcomes and survivorship of ArTHA in a relatively large cohort with an age and gender matched TrTHA cohort. Our study further determines: 1) the complication profiles and rerevision rate in both cohorts; and 2) the functional outcomes and survivorship of ArTHA and TrTHA with different surgical approaches.

Patients and Methods

With Caldicott approval, we reviewed all ArTHA cases with an age and sex matched cohort of TrTHA from a prospective arthroplasty database that registers every patient undergoing joint arthroplasty in our region. The TrTHA cohort was selected from a possible 883 cases where:

- Age was between the minimum and maximum ages in the ArTHA cohort;
- Date of operation was between the earliest and latest dates of operation in the ArTHA cohort; and
- Surgery was performed at the same hospitals as those in the ArTHA cohort.

An individual match for each ArTHA case was randomly selected from a subset of TrTHA cases of the same gender, age and year of operation. Where none existed, age matching was relaxed in increments of 1 year either way, to a maximum of 3 years until a match was found. When more than one possible match existed, the TrTHA case was randomly chosen. If they remained unmatched, the ArTHA cases were excluded.

The functional outcomes for rTHA were based on Harris Hip Score (HHS) according to pain, function and the total score (Appendix 1). The reason for rTHA, the preoperative HHS and at years 1, 3 and 5 across both cohorts were identified and compared. In addition, the functional outcomes between the ArTHA and TrTHA cohorts with different surgical approaches were further analysed. Our grouping cohorts were: acetabulum-only revision total hip arthroplasty with anterolateral approach [ArTHA (AL)], acetabulum-only revision total hip arthroplasty with posterior approach [ArTHA (P)], total revision total hip arthroplasty with anterolateral approach [TrTHA (AL)] and total revision total hip arthroplasty with posterior approach [TrTHA (P)]. Subsequently, the rerevision rate and indication for rerevision were compared between the study cohorts.

The Charnley Classification was used to assess patient's comorbidities where:

- A - 1 hip affected;
- B - both hips affected;
- C - multiple joint disease or other disabilities leading to difficulties in walking [11].

Medical and surgical complications were compared. Chest pain, myocardial infarction and cardiac arrest were considered as cardiac complications. Gastrointestinal bleeding was classified as a gastrointestinal complication. Urinary tract infection and acute kidney injury were classified as renal complications. Chest infection was classified as a respiratory complication. Wound complications included delayed wound healing, wound dehiscence, excessive bleeding, blistering and excessive bruising. For infection complications, we only considered positive laboratory culture and reported superficial and deep infection during hospital stay. Reported nerve deficit and ankle dorsiflexion weakness were considered as nerve injury complications. Patients with more than one complication reported were placed into '>1 complications' category. For surgical complications, we specifically recorded the incidence of acute dislocation and acute periprosthetic fracture.

Statistical analysis was performed using Statistical Package for the Social Sciences software (SPSS for Microsoft, Version 21.0). The mean, range and percentage were used for descriptive statistics. The Shapiro-Wilk test was used to test data normality and the Mann-Whitney test was used to assess the statistical significance between ArTHA and TrTHA cohorts. The Kruskal Wallis test was used to assess the statistical significance between both cohorts with different surgical approaches. The Kaplan-Meier survivorship, with the need for rerevision surgery as the endpoint, was used for survival analysis. Censored observations, such as patients who died and those who were lost to follow-up were included in the survivorship analysis. The survivorship analysis was based on the assumption that not all implants will be revised and even if the exact time of rerevision for censored observations was not known, the implant was at least known to be unrerevised before being censored [12]. The log-rank test was used to identify significant differences between the survival curves of the study cohorts. A p-value less than 0.05 were regarded as statistically significant.

Results

There were 355 ArTHA cases in the regional database, from year 1993 to 2014. 39 unmatched cases, 12 hip resurfacing cases and 1 deceased case with insufficient detail were excluded. We compared a total of 269 ArTHA cases to a randomised age and gender matched TrTHA cohort. Among the 538 cases, we had a rate of loss of 29.7% (160 out of 538) with a 68.1% (109 out of 160) death rate within these lost cases, from an unrelated event. The rate of loss was similar across both ArTHA and TrTHA cohorts (29.4% *vs* 30.1%). We have assumed that the causes of loss to follow up other than death itself, were similar in the two cohorts.

Patient demographics are shown in Table 1. The majority of patients fell into Charnley Class C for both ArTHA and TrTHA cohorts. The BMI and survival years did not differ significantly for both cohorts (p = 0.468; 0.942). The length of hospital stay for the ArTHA cohort was significantly shorter than for the TrTHA cohort (9 days *vs* 12 days; p = 0.001). At year 1, our institute achieved patient satisfaction rates of 93.4% (184 out of 197) and 95.9% (188 out of 196) for ArTHA and TrTHA cohorts respectively. At year 5, our institute again achieved comparative patient satisfaction rates for both ArTHA and TrTHA cohorts [93.5% (87 out of 93) *vs* 92.8% (90 out of 97)]. The most common indication for performing rTHA for both cohorts was aseptic loosening, followed by dislocation for ArTHA and infection for the TrTHA cohort (Table 2).

The comparison of HHS for pain, function and total score are shown in Figure 1 (a, b and c). The preoperative HHS for pain, function and total were better in the ArTHA cohort, but only the function score reached statistical significance [(function score, p = 0.020); (pain and total score, p = 0.154; 0.053)]. Furthermore, there were no significant differences in subsequent years for all aspects of HHS, except the function score was significantly better in the ArTHA cohort at year 1 (p = 0.045). Further analysis revealed that the TrTHA cohort had a higher score improvement at year 1 than the ArTHA cohort in all 3 aspects of HHS, but only HHS for pain reached statistical significance (p = 0.021) (Table 3).

During our study period, we had 149 ArTHA (AL), 118 ArTHA (P), 130 TrTHA (AL) and 135 TrTHA (P) cases. 6 cases were excluded as no surgical approaches were recorded. The comparison of all 3 aspects of HHS for the surgical approaches are shown in Figure 2 (a, b and c). ArTHA (P) group was associated with the best preoperative HHS and performed best in the subsequent years for function and total HHS. However, none of the recorded parameters at any point of this study, including preoperative, postoperative and score improvement at 1 year reached statistical significance.

There were no intraoperative deaths in our study cohorts. With regard to surgical complications, our study had an acute periprosthetic fracture rate of 0.74% (2 out of 269) in the ArTHA cohort and 7.43% (20 out of 269) in the TrTHA cohort. However, we were unable to identify if they were acetabular or femoral fractures, due to insufficient detail in the database. The dislocation rates were similar in both ArTHA and TrTHA cohorts (6.0% *vs* 5.6%). However, the dislocation rate was the lowest for the ArTHA (P) group, followed by TrTHA (P), TrTHA (AL) then ArTHA (AL) group (3.4%; 4.4%; 6.9% and 8.1%). The ArTHA cohort was associated with fewer medical complications than the TrTHA cohort (4.1% *vs* 12.6%). Wound infection was the most common postoperative medical complication in our study cohorts (Table 4).

In our study, 27 (10.0%) of ArTHAs and 21 (7.8%) of TrTHAs had required rerevision. The 5-year survivorship was 90.3% (95% CI ± 2.1%) for the ArTHA cohort and 92.7% (95% CI ± 1.8%) for the TrTHA cohort. There was no statistical difference between ArTHA and TrTHA cohorts in the Kaplan-Meier survivorship analysis ($p = 0.394$) (Figure 3). The ArTHA (AL) group appeared to have the shortest 5-year Kaplan-Meir survivorship of 89.7% (95% CI ± 2.9%), followed by ArTHA (P) group with survivorship of 90.9% (95% CI ± 3.0%), TrTHA (AL) with survivorship of 91.4% (95% CI ± 3.1%) and the TrTHA (P) group with the longest survivorship of 92.4% (95% CI ± 2.8%); with a non-significant p-value of 0.533 (Figure 4). The indications for rerevision were similar to rTHA, with similar rerevision rate due to aseptic loosening in both ArTHA and TrTHA cohorts. Our study had one rerevision due to periprosthetic fracture in the ArTHA cohort (Table 5).

Discussion

When presented with one loose component and one stable component, surgeons have the choice of performing a single component or both components revision. ArTHA is indicated for acetabulum component failure when the femoral implant remains well fixed [2, 13]. Our retrospective review has demonstrated that ArTHA can provide similar functional outcome, dislocation rate and acceptable revivision rate as TrTHA, with the addition of fewer postoperative medical complications.

It is well known that rTHA is commonly associated with a higher complication rate, associated with more extensive blood loss and a longer operative time, than primary THA [4, 14]. Surgeons are generally more cautious when selecting patients for rTHA as patients are older and often less healthy than they were at the time of the primary arthroplasty [14]. Increasing age and medical comorbidities are both predictors of major postoperative complications following rTHA [14]. Despite that, Parvizi *et al.* demonstrated that rTHA can provide substantial clinical benefits to octogenarians and the prevalence of medical complications did not appear to differ significantly when compared to younger patients [15]. Our study had a mean age of 72 ± 9 years, which was slightly older than in most studies [16-19] and most of our patients fell into Charnley Class C. Despite that, our medical complication rates for both ArTHA and TrTHA cohorts were still generally lower than in the literature [14].

Traditionally, rTHA is thought to be associated with lower patient satisfaction and less functional improvement than primary THA [20]. Eisler *et al.* further reported that patients actually have high expectations regarding rTHA: 92% of 66 consecutive rTHA patients expected to have much less pain and 82% of them expected the same walking ability as with primary THA, following rTHA [21]. Philpott *et al.* performed a retrospective observational study on rTHA patients with a minimum 10 years follow up and demonstrated a patient satisfaction rate of 92% post rTHA [22]. Similarly, our institute was able to achieve comparable satisfaction rates to the literature for both cohorts.

With regard to functional improvement, Cho *et al.* demonstrated an improvement of 33.4 points on the average HHS at 9.2 years follow up, on 29 isolated acetabulum revisions [3]. Our study had a lower improvement in HHS than the literature. This was possibly due to a lower preoperative HHS for both cohorts than in the literature. Therefore, the results were not likely to be limited by retention of the femoral component. Despite that, our study still demonstrated an overall high level of patient satisfaction following rTHA in both cohorts.

rTHA is known to be associated with a higher dislocation risk and periprosthetic fracture risk than primary THA. One large prospective cohort study on rTHA reported a periprosthetic fracture rate of 4% from day 1 to 30 post-operatively [23]. We were unable to determine if our ‘acute periprosthetic fracture’ occurred intraoperatively or postoperatively within the hospital stay due to insufficient detail in the documentation. However, our periprosthetic fracture rates were within the range reported in previous intraoperative series, with a lower rate in the ArTHA cohort [23, 24]. Some studies reported a higher dislocation rate (8% to 25%) after ArTHA than after TrTHA [4, 25, 26], which was not observed in our study.

There is no agreement on the optimal exposure during rTHA [3]. Several patient and surgical factors have been proposed that might influence the risk of dislocation following rTHA [6, 27, 28]. Alberton *et al.* reported a dislocation rate of 7.4% following rTHA. They suggested that there was no significant association between surgical approach and dislocation rate. The authors further concluded that the extent of soft tissue dissection plays the main role in hip stability after rTHA [28]. Furthermore, surgical approach can be one of the risk factors for cup malpositioning and have tremendous effect on the implant stability [29, 30]. There is a fear of dislocation with the posterior approach, which this study addresses. However, generally speaking, the posterior approach provides the best visualisation of the acetabulum, particularly in cases with extensive bone loss. Posterior capsulotomies can often be managed by increasing the acetabular anteversion and the performance of a robust soft tissue repair. In rTHA, it can be difficult to locate the short external rotators and capsule with a previous posterior approach. Commonly, the posterior soft tissue is attached to the posterior border of the greater trochanter as a single layer without distinguishing the capsule from the short external rotators. In some cases, posterior soft tissue repair is impossible due to increased offset for stability [9]. Suh *et al.* demonstrated a markedly decreased dislocation rate after posterior capsule and short external rotators repair [9]. In many cases, the fibrous scar tissue actually provides excellent purchase for surgical sutures. It has been reported that ArTHA via the posterior approach has been associated with one of the highest overall rates of dislocation [25], which is not consistent with our study where our ArTHA via posterior approach group achieved the best functional outcome and lowest dislocation rate. In this study, surgical approach was decided by the individual surgeon’s preference. There were undoubtedly many cases of using a posterior approach for a revision after an anterolateral approach for a primary. There will have been some cases where the converse applied, but the database did not contain the detail to comment upon this further.

Extensive literature searches revealed three published papers to have greater than 1000 rTHA cases with overall survivorship of 82% at 10 years [22, 31]. The implant survival in the literature varied, depending on the indication for revision surgery, the cohort size and follow up time [22, 31]. The performance for both of our cohorts in the 5-year Kaplan-Meier cumulative survival analysis was not significantly different. We cannot find any evidence to suggest that the statistically non-significant but slightly lower survivorship for the ArTHA cohort was due to the preservation of the original femoral component. Importantly, we were able to achieve a lower dislocation rate, a lower periprosthetic fracture rate and an acceptable rerevision rate and survivorship in both cohorts, compared to other studies [22, 31].

To our knowledge, this is the first large age and gender matched comparative study of ArTHA and TrTHA cohorts. We acknowledge that the current study has certain limitations. The reduced cohort sizes when adding in the factor of surgical approach means that any conclusion about implant survivorship for each surgical approach needs to be interpreted with caution. Albeit not statistically significant, our results indicated a trend of best functional outcomes with ArTHA (P) but slightly lower survivorship than both TrTHA approach groups by a very small margin. This may be important for the surgeon when making decisions about rTHA, particularly in young patients. Further investigation regarding the best surgical approach is still warranted, but our study does provide a realistic outcome prediction for both surgeons and patients regarding the longevity of the prosthesis and also the quality of life after rTHA. The issue of patients lost to follow up is common in studies of this kind. We do not have information on these patients other than those who had died, where that fact is straightforward to determine with current National Health Service (NHS) record keeping. However, we do not consider that this is critical in the study, given that the proportion is roughly the same in both cohorts.

The documentation on our prospectively collected database is necessarily limited, and in certain areas such as the issue of periprosthetic fractures, there is little detail available. Recourse to the clinical notes has not been possible in many cases, as a significant number of these records are no longer available. This same limitation also applies to the issue over what was the condition of the femoral component in the two main cohorts. The policy in our unit, with all the surgeons, has been only to revise the components which seemed loose or, rarely, problematic in some other way, such as component version. This was determined by preoperative assessment and imaging, and also by the surgeon's intraoperative judgement. We believe that this reflects most surgeons' practice. In essence, very few stable implants were revised, the main exception being those few well fixed acetabular components in the TrTHA group which had significant polyethylene wear.

We did not find evidence of the femoral component frequently needing to be revised after ArTHA within the time period of the study. The argument is still occasionally advanced when considering rTHA that a 'fresh start' is best by revising both components, even if only one is loose. On the other hand, Moskal *et al.* concluded that ArTHA does not adversely affect both the acetabulum exposure and the stability of acetabulum component [32]. Stathopoulos *et al.* further revealed a similar rerevision rate for ArTHA and TrTHA (21% *vs* 22%), suggesting that it is not justifiable to revise a stable component [4]. In our practice, if there was a well fixed monobloc stem such as a Charnley in ArTHA, we would ordinarily accept any minor scratches on the femoral head, rather than embark on a full femoral revision. If there was a modular head then we would change that to a new one, which also improved access. The rise of cement within cement revision may reduce the operative morbidity from cement removal [33] but this was not a significant feature of our practice at the time of this study.

Controversy continues to exist regarding the best fixation method in THA and its subsequent revision risk [34-36]. The most common cause of revision and rerevision were aseptic loosening in both cohorts, which is consistent with the literature [4, 18]. The Norwegian Arthroplasty Register demonstrated a rerevision rate of 6% (165 out of 2751) for ArTHA [17] whereas another study on 27 unrevised femoral components demonstrated a failure rate of 22% with ArTHA [4]. Our rerevision rate for ArTHA cohort (10.0%) was within this reported range. However, our study has limitations in assessing the effectiveness of implant design, fixation method and bearing surfaces on the implant's longevity and its effect on aseptic loosening. Firstly, despite being a relatively large comparative study, further subdividing the study cohort into cemented/ uncemented fixation would reduce the cohort size further and resulted in a bias conclusion. Secondly, large register based observational studies as well as systemic reviews and well conducted prospective randomised trial are better research methodology in assessing the survival of THA [34]. The aim of our study is not to determine which primary implant or fixation method is the most ideal, but to answer the relevant practical question of what can one do when present with a stable femoral and a loose acetabular component.

In conclusion, our study further confirms the clinical justification for performing ArTHA when clinically indicated. ArTHA can provide similar functional outcome, dislocation rate and acceptable rerevision rate as TrTHA, with addition of fewer postoperative medical complications. Further study regarding surgical approaches is still warranted, but there was no evidence in this study to suggest that the posterior approach had a higher dislocation rate, and it can be safely used in either ArTHA or TrTHA without an increased risk of instability, and potentially with superior acetabular visualisation.

(3576 words)

References

[1] de Thomasson E, Conso C, Mazel C. A well-fixed femoral stem facing a failed acetabular component: to exchange or not? A 5- to 15-year follow-up study. Orthop Traumatol Surg Res 2012; 98(1):24-29.

[2] Berry DJ, Trousdale RT, Dennis DA, Paprosky WG. Revision Total Hip and Knee Arthroplasty. Lippincott Williams & Wilkins; 2012. p. 65-74.

[3] Cho HJ, Han SB, Park JH, Park SW. An analysis of stably fixed femoral components retained during revision total hip arthroplasty. J Arthroplasty 2011; 26(8):1239-1244.

[4] Stathopoulos IP, Lampropoulou-Adamidou KI, Vlamis JA, Georgiades GP, Hartofilakidis GC. One-Component Revision in Total Hip Arthroplasty: The Fate of the Retained Component. J Arthroplasty 2014; 29(10):2007-2012.

[5] Poon ED, Lachiewicz PF. Results of isolated acetabular revisions: the fate of the unrevised femoral component. J Arthroplasty 1998; 13(1):42-49.

[6] Wetters NG, Murray TG, Moric M, Sporer SM, Paprosky WG, Della Valle CJ. Risk factors for dislocation after revision total hip arthroplasty. Clin Orthop Relat Res 2013; 471(2):410-416.

[7] Palan J, Beard DJ, Murray DW, Andrew JG, Nolan J. Which approach for total hip arthroplasty: anterolateral or posterior? Clin Orthop Relat Res 2009; 467(2):473-477.

[8] Hailer NP, Weiss RJ, Stark A, Karrholm J. The risk of revision due to dislocation after total hip arthroplasty depends on surgical approach, femoral head size, sex, and primary diagnosis. An analysis of 78,098 operations in the Swedish Hip Arthroplasty Register. Acta Orthop 2012; 83(5):442-448.

[9] Suh KT, Roh HL, Moon KP, Shin JK, Lee JS. Posterior Approach With Posterior Soft Tissue Repair in Revision Total Hip Arthroplasty. J Arthroplasty 2008; 23(8):1197-1203.

[10] Mast NH, Laude F. Revision total hip arthroplasty performed through the Hueter interval. J Bone Joint Surg Am 2011; 93 Suppl 2:143-148.

[11] Bjorgul K, Novicoff WM, Saleh KJ. Evaluating comorbidities in total hip and knee arthroplasty: available instruments. J Orthop Traumatol 2010; 11(4):203-209.

[12] Ranstam J, Kärrholm J, Pulkkinen P, Mäkelä K, Espehaug B, Pedersen AB, et al. Statistical analysis of arthroplasty data: I. Introduction and background. Acta Orthopaedica 2011; 82(3):253-257.

[13] Taylor ED, Browne JA. Reconstruction options for acetabular revision. World J Orthop 2012; 3(7):95-100.

[14] Koenig K, Huddleston Iii JI, Huddleston H, Maloney WJ, Goodman SB. Advanced Age and Comorbidity Increase the Risk for Adverse Events After Revision Total Hip Arthroplasty. J Arthroplasty 2012; 27(7):1402-1407.e1401.

[15] Parvizi J, Pour AE, Keshavarzi NR, D'Apuzzo M, Sharkey PF, Hozack WJ. Revision total hip arthroplasty in octogenarians. A case-control study. J Bone Joint Surg Am 2007; 89(12):2612-2618.

[16] Biring GS, Masri BA, Greidanus NV, Duncan CP, Garbuz DS. Predictors of quality of life outcomes after revision total hip replacement. J Bone Joint Surg Br 2007; 89(11):1446-1451.

[17] Lie SA, Havelin LI, Furnes ON, Engesaeter LB, Vollset SE. Failure rates for 4762 revision total hip arthroplasties in the Norwegian Arthroplasty Register. J Bone Joint Surg Br 2004; 86(4):504-509.

[18] Trumm BN, Callaghan JJ, George CA, Liu SS, Goetz DD, Johnston RC. Minimum 20-Year Follow-Up Results of Revision Total Hip Arthroplasty With Improved Cementing Technique. J Arthroplasty 2014; 29(1):236-241.

[19] Davis AM, Agnidis Z, Badley E, Kiss A, Waddell JP, Gross AE. Predictors of functional outcome two years following revision hip arthroplasty. J Bone Joint Surg Am 2006; 88(4):685-691.

[20] Jibodh SR, Kandil AO, Malchau H, Estok Ii DM. Do Commonly Reported Outcome Measures Reflect Patient Satisfaction After Revision Hip Arthroplasty? J Arthroplasty 2010; 25(1):41-45.

[21] Eisler T, Svensson O, Tengström A, Elmstedt E. Patient expectation and satisfaction in revision total hip arthroplasty. J Arthroplasty 2002; 17(4):457-462.

[22] Philpott A, Weston-Simons JS, Grammatopoulos G, Bejon P, Gill HS, McLardy-Smith P, et al. Predictive outcomes of revision total hip replacement—A consecutive series of 1176 patients with a minimum 10-year follow-up. Maturitas 2014; 77(2):185-190.

[23] Singh JA, Jensen MR, Lewallen DG. Patient Factors Predict Periprosthetic Fractures After Revision Total Hip Arthroplasty. The Journal of Arthroplasty 2012; 27(8):1507-1512.

[24] So K, Kuroda Y, Matsuda S, Akiyama H. Revision total hip replacement with a cemented long femoral component: minimum 9-year follow-up results. Arch Orthop Trauma Surg 2013; 133(6):869-874.

[25] Manning DW, Ponce BA, Chiang PP, Harris WH, Burke DW. Isolated Acetabular Revision Through the Posterior Approach: Short-term Results after Revision of a Recalled Acetabular Component. The Journal of Arthroplasty 2005; 20(6):723-729.

[26] Ito H, Matsuno T, Aoki Y, Minami A. Acetabular components without bulk bone graft in revision surgery:: A 5- to 13-year follow-up study. J Arthroplasty 2003; 18(2):134-139.

[27] Carter AH, Sheehan EC, Mortazavi SM, Purtill JJ, Sharkey PF, Parvizi J. Revision for recurrent instability: what are the predictors of failure? J Arthroplasty 2011; 26(6 Suppl):46-52.

[28] Alberton GM, High WA, Morrey BF. Dislocation After Revision Total Hip Arthroplasty: An Analysis of Risk Factors and Treatment Options. J Bone Joint Surg Am 2002; 84(10):1788-1792.

[29] Callanan MC, Jarrett B, Bragdon CR, Zurakowski D, Rubash HE, Freiberg AA, et al. The John Charnley Award: risk factors for cup malpositioning: quality improvement through a joint registry at a tertiary hospital. Clin Orthop Relat Res 2011; 469(2):319-329.

[30] Danoff JR, Bobman JT, Cunn G, Murtaugh T, Gorroochurn P, Geller JA, et al. Redefining the Acetabular Component Safe Zone for Posterior Approach Total Hip Arthroplasty. J Arthroplasty 2016; 31(2):506-511.

[31] Springer BD, Fehring TK, Griffin WL, Odum SM, Masonis JL. Why revision total hip arthroplasty fails. Clin Orthop Relat Res 2009; 467(1):166-173.

[32] Moskal JT, Shen FH, Brown TE. The fate of stable femoral components retained during isolated acetabular revision: a six-to-twelve-year follow-up study. J Bone Joint Surg Am 2002; 84-a(2):250-255.

[33] Duncan WW, Hubble MJ, Howell JR, Whitehouse SL, Timperley AJ, Gie GA. Revision of the cemented femoral stem using a cement-in-cement technique: a five- to 15-year review. J Bone Joint Surg Br 2009; 91(5):577-582.

[34] Mäkelä KT, Matilainen M, Pulkkinen P, Fenstad AM, Havelin L, Engesaeter L, et al. Failure rate of cemented and uncemented total hip replacements: register study of combined Nordic database of four nations. BMJ : British Medical Journal 2014; 348.

[35] Wyatt M, Hooper G, Frampton C, Rothwell A. Survival outcomes of cemented compared to uncemented stems in primary total hip replacement. World Journal of Orthopedics 2014; 5(5):591-596.

[36] Abdulkarim A, Ellanti P, Motterlini N, Fahey T, O'Byrne JM. Cemented versus uncemented fixation in total hip replacement: a systematic review and meta-analysis of randomized controlled trials. Orthopedic Reviews 2013; 5(1):e8.

Figure 1a

Click here to download Figures (Number each one): HHS Pain_1.eps

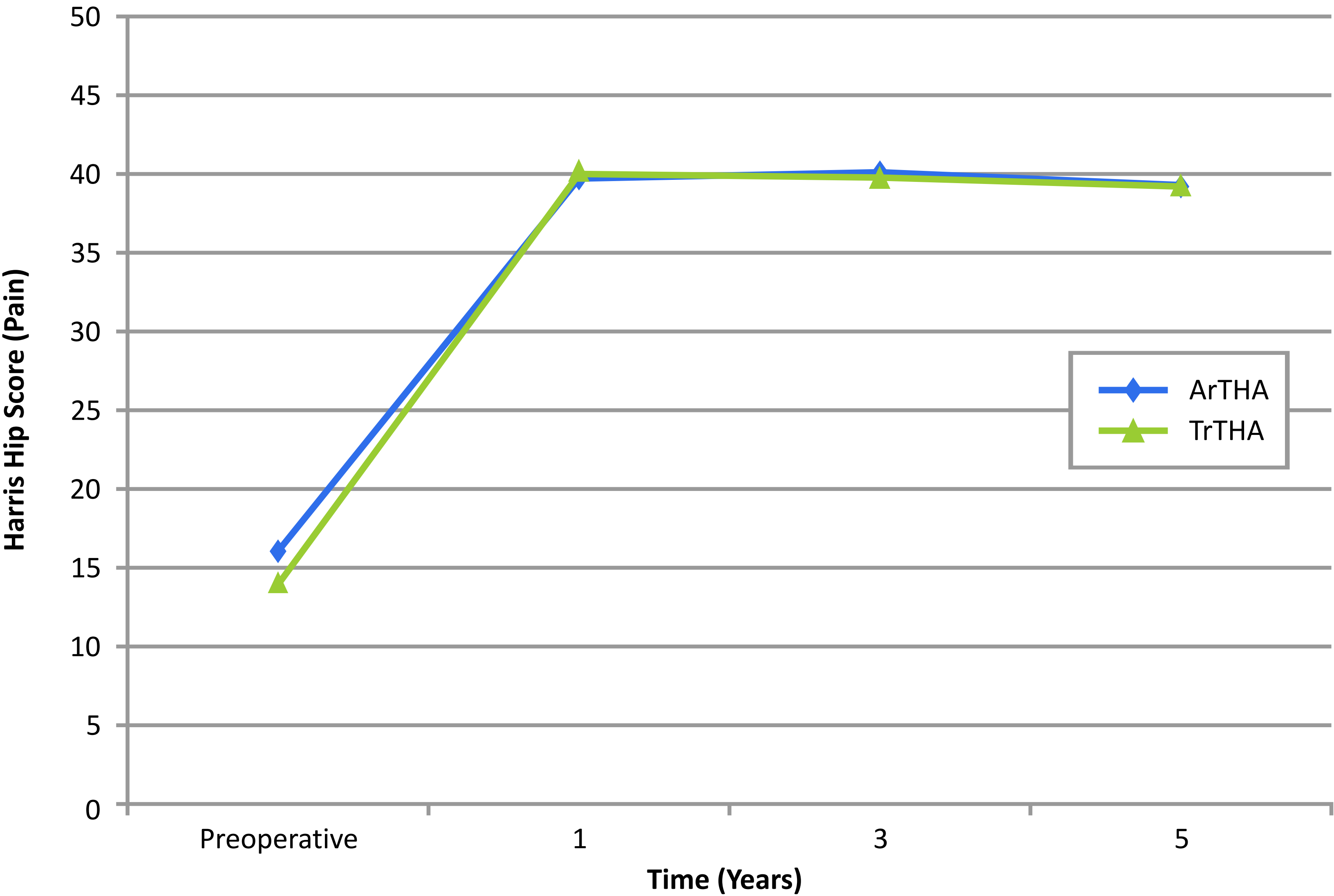

Figure 1b
Click here to download Figures (Number each one): HHS Function_1.eps

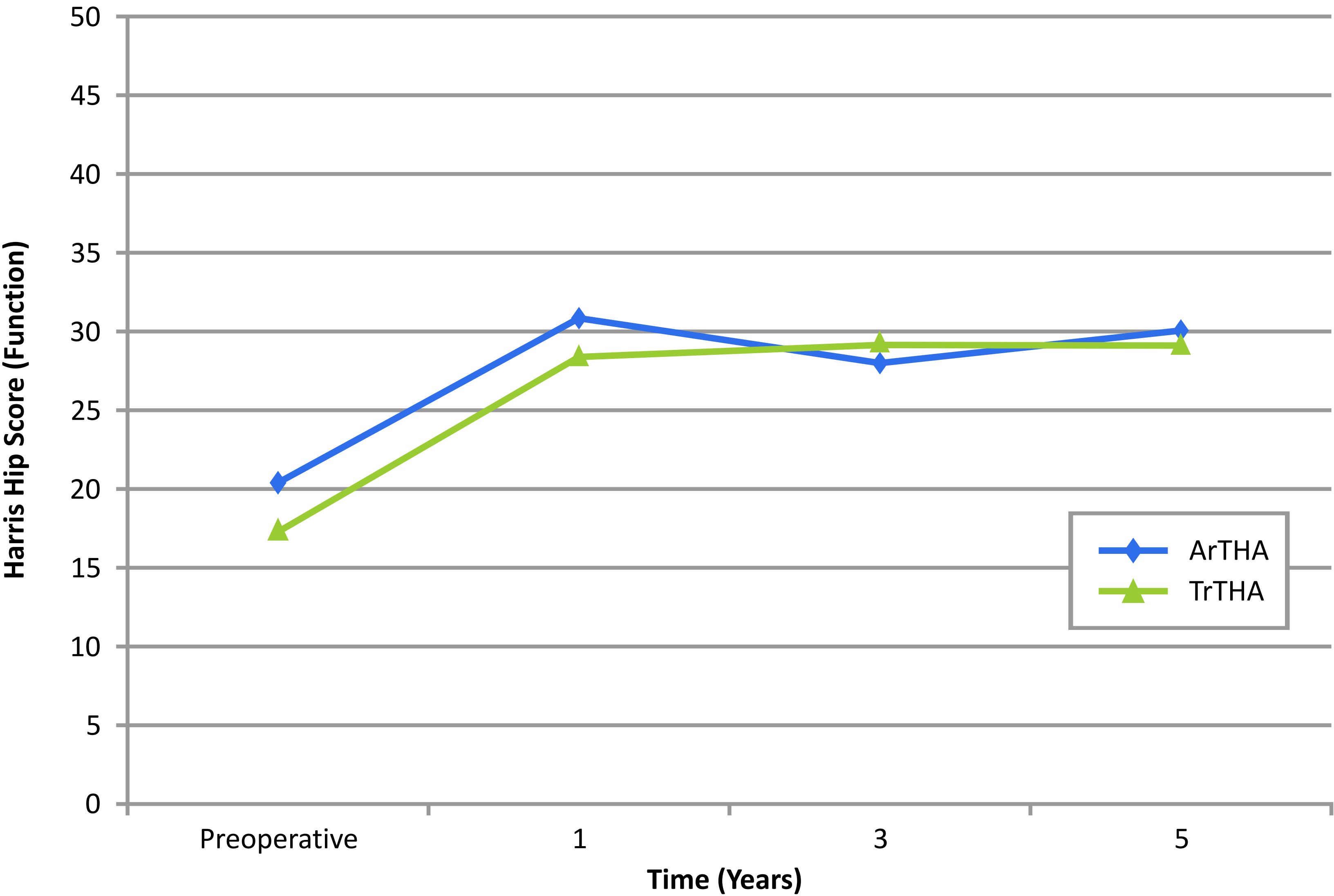

Figure 1c
Click here to download Figures (Number each one): HHS Total_1.eps

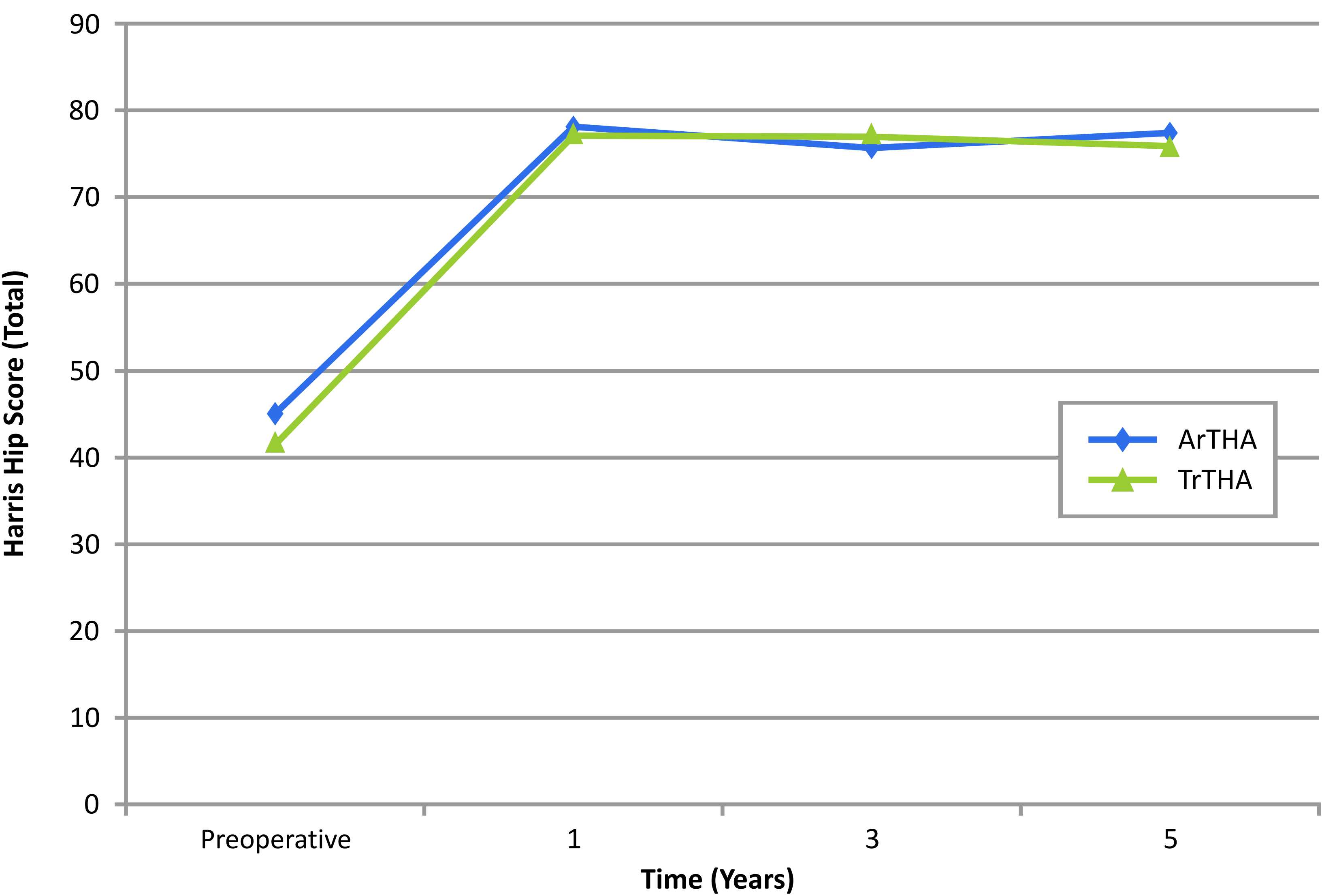

Figure 2a

Click here to download Figures (Number each one): HHS Pain_2.eps

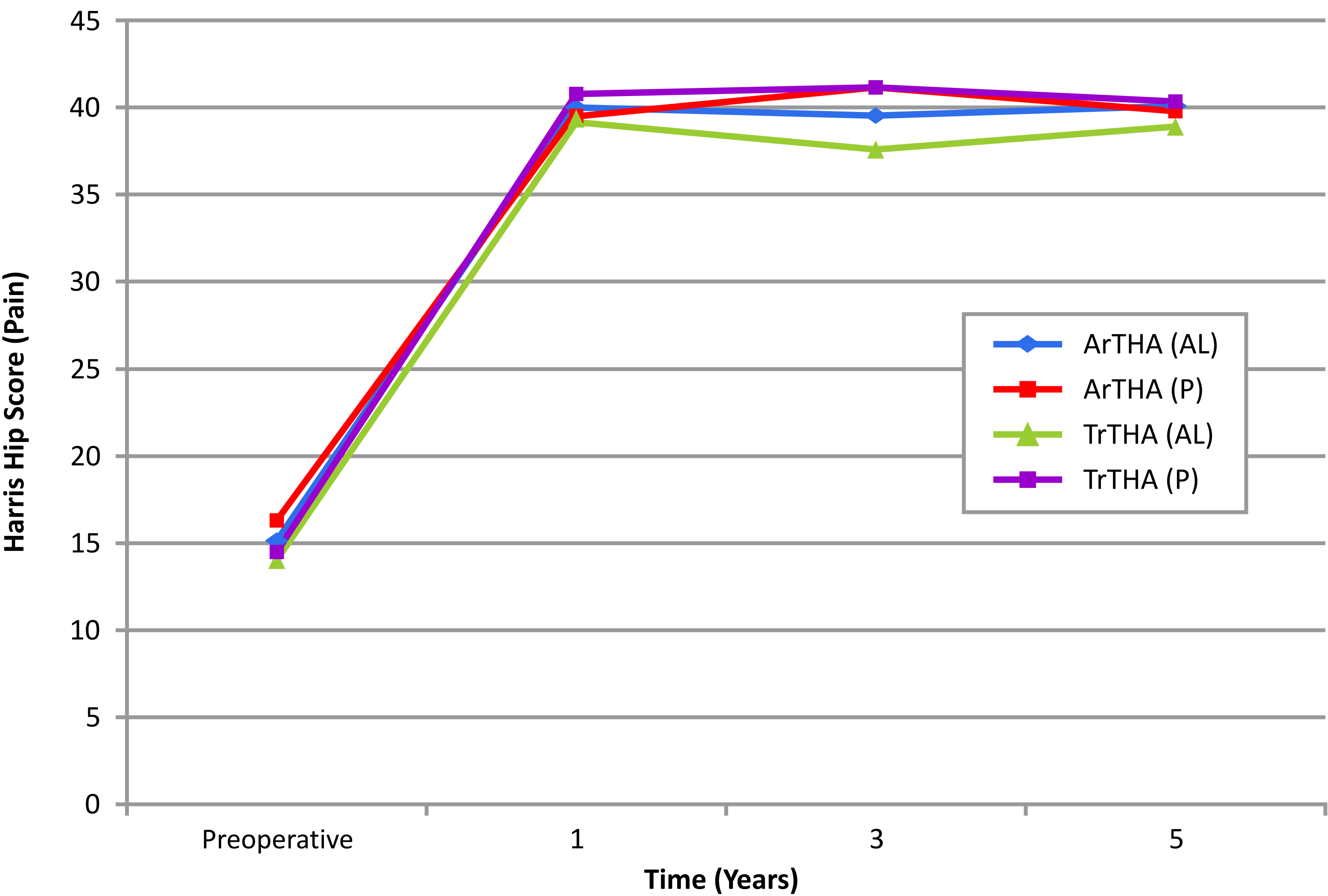

Figure 2b
Click here to download Figures (Number each one): HHS Function_2.eps

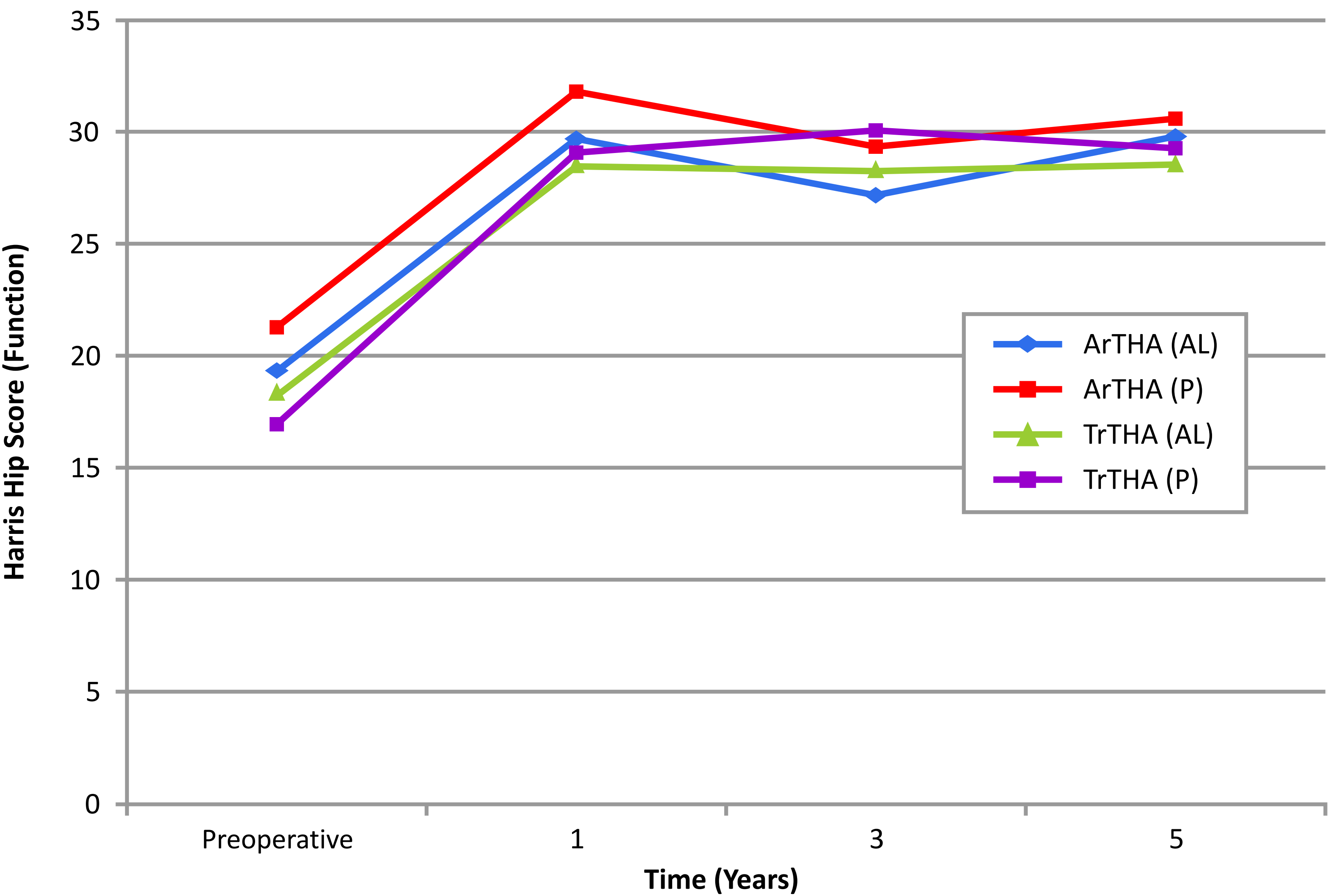

Figure 2c

Click here to download Figures (Number each one): HHS Total_2.eps

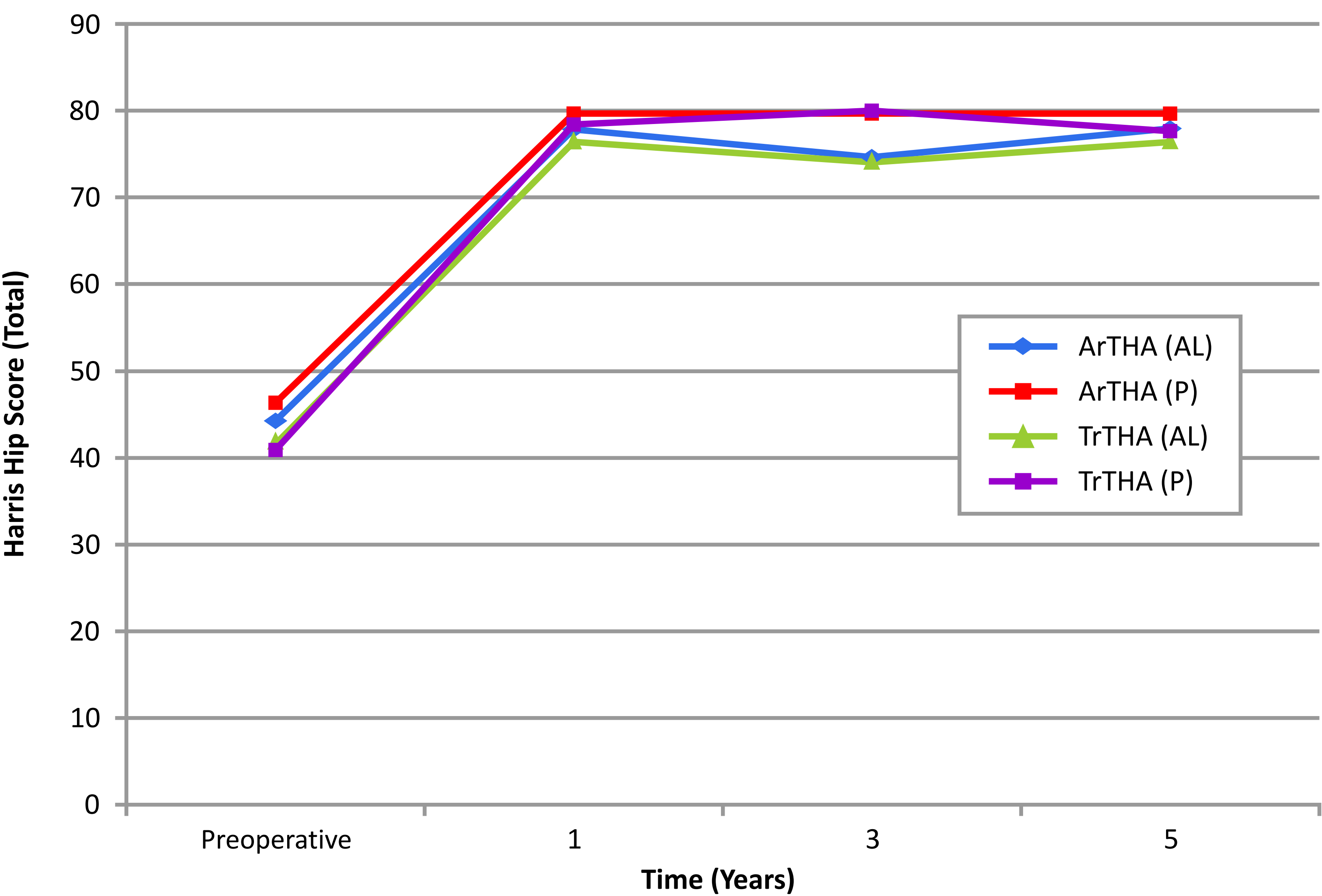

Figure 3

Click here to download Figures (Number each one): Survival Graph_1.eps

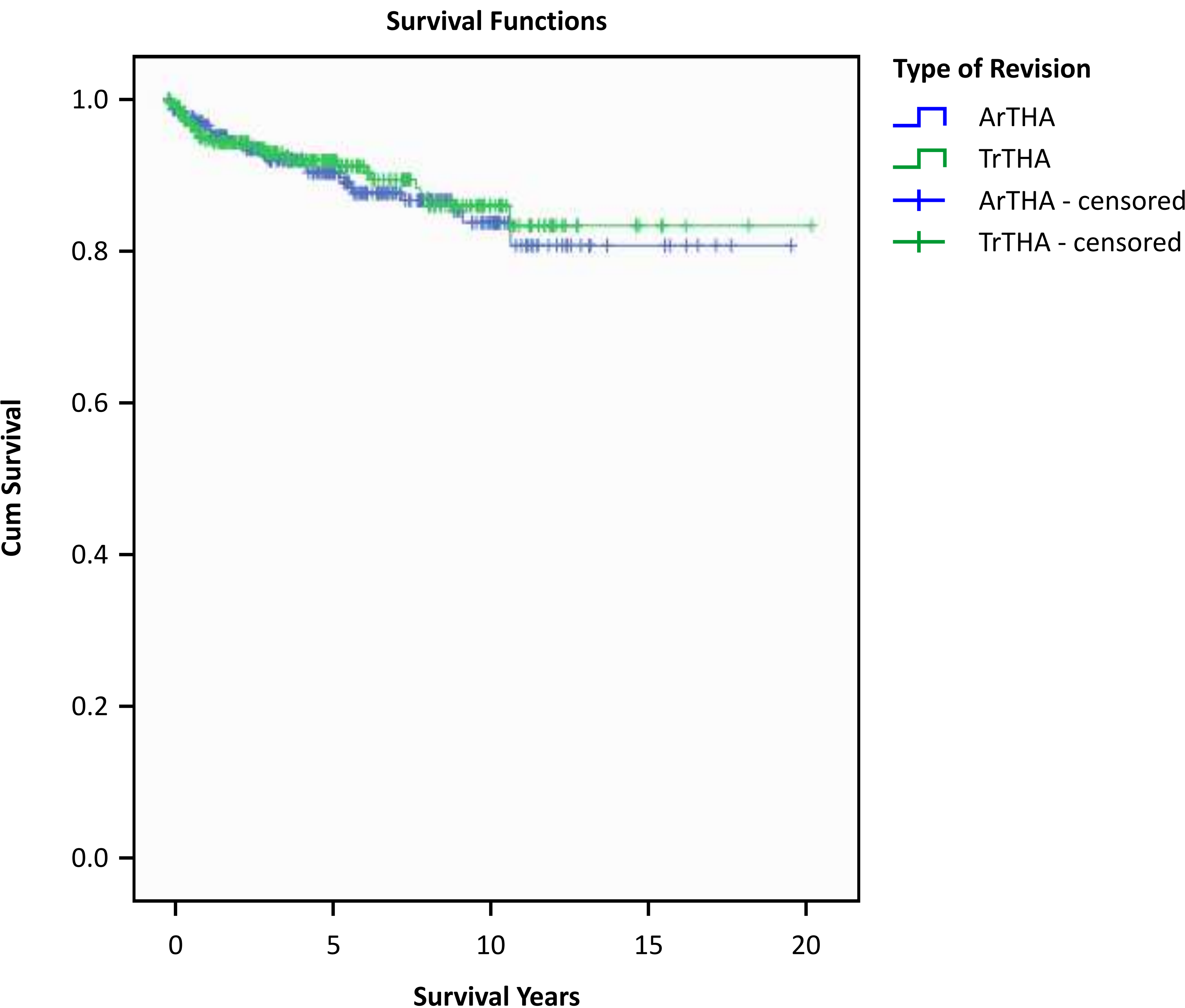

Figure 4
Click here to download Figures (Number each one): Survival Graph_2.eps

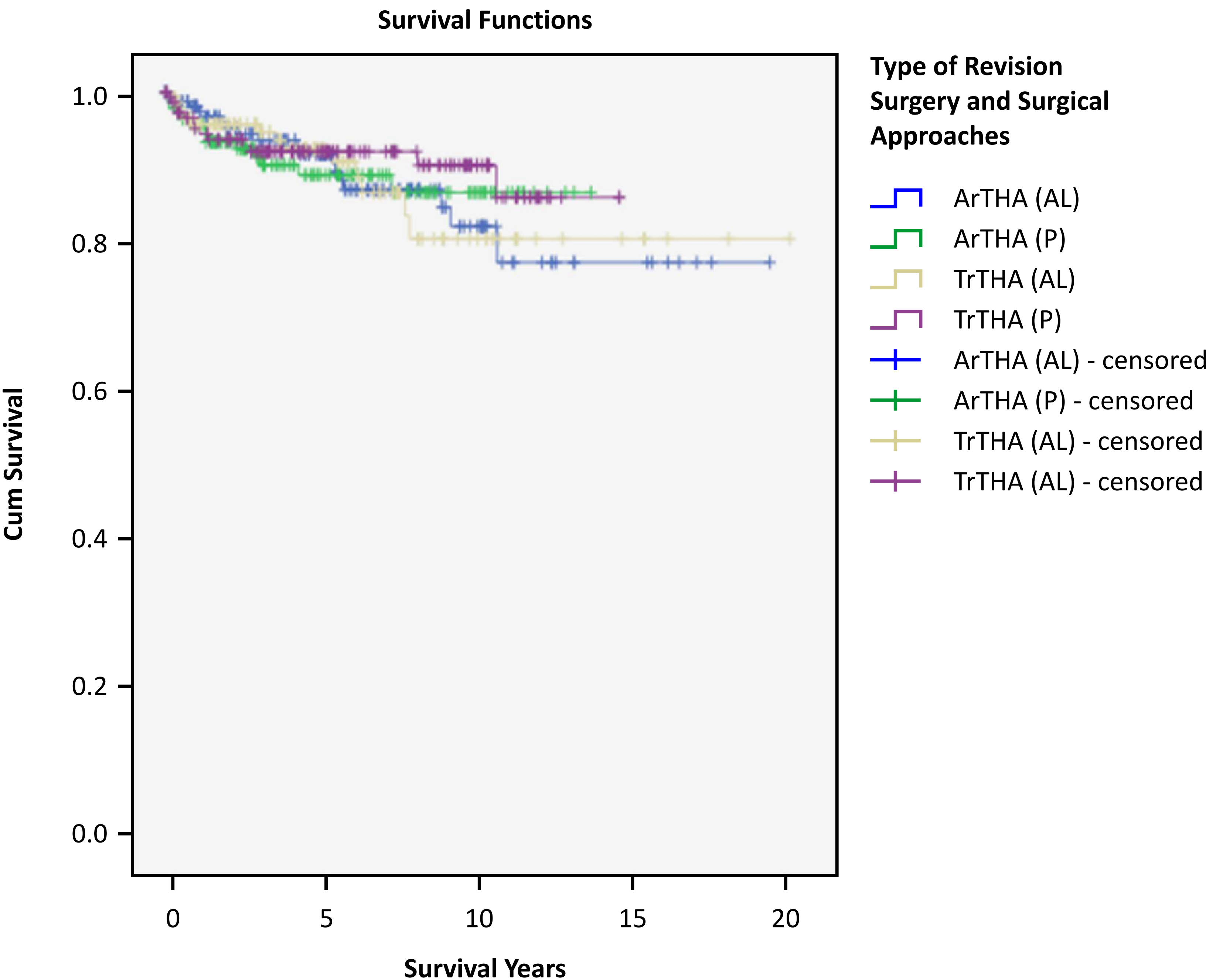

Figure Legends:

Figure 1a: Harris Hip Score (Pain) over 5-year.

Figure 1b: Harris Hip Score (Function) over 5-year.

Figure 1c: Harris Hip Score (Total) over 5-year.

Figure 2a: Harris Hip Score (Pain) over 5-year in different surgical approach groups.

Figure 2b: Harris Hip Score (Function) over 5-year in different surgical approach groups.

Figure 2c: Harris Hip Score (Total) over 5-year in different surgical approach groups.

Figure 3: Kaplan Meir survivorship for ArTHA and TrTHA cohorts.

Figure 4: Kaplan Meir survivorship for different surgical approach groups.

Appendix

Appendix 1: Harris Hip Score.

Category	**Harris Hip Score**
Excellent	90-100
Good	80-89
Fair	70-79
Poor	<70

Tables

Table 1: Patient demographics.

Variables		ArTHA n	ArTHA Mean ± STDEV	ArTHA Range	TrTHA n	TrTHA Mean ± STDEV	TrTHA Range
Gender (F:M)		269	165:104		269	165:104	
Leg (L:R)		269	109:160		269	129:140	
Age		269	72 ± 9	43 to 93	269	72 ± 9	43 to 92
BMI		232	27.4 ± 4.5	17 to 41	223	27.9 ± 5.2	16 to 48
Survival Years		269	5.49 ± 3.86	0.01 to 18.89	269	5.45 ± 3.81	0.05 to 19.51
Hospital Stay		265	9 ± 7	2 to 66	268	12 ± 14	2 to 123
Preoperative Charnley Class	**A**	54/215			61/227		
	B	21/215			20/227		
	C	140/215			146/227		

Tables 2

Table 2: Indication for rTHA.

Indication for rTHA	ArTHA (%)	TrTHA (%)
Aseptic Loosening	70.9	61.5
Dislocation	20.5	7.4
Fracture	1.2	2.7
Implant Failure	1.2	0.0
Infection	1.2	23.7
Instability	2.4	1.9
Unexplained Pain	2.4	2.3
Others	0.4	0.4

Table 3: The improvement of Harris Hip Scores at year 1.

Score Improvement at Year 1	**ArTHA**			**TrTHA**			**p-value**
	n	**Mean ± STDEV**	**Range**	**n**	**Mean ± STDEV**	**Range**	
Pain	186	24.14 ± 11.55	-24 to 44	180	26.41 ± 11.12	-10 to 44	0.021
Function	172	10.58 ± 9.36	-10 to 45	169	10.65 ± 9.73	-13 to 37	0.420
Total	133	34.73 ± 17.37	-29 to 69	127	36.59 ± 15.89	-10 to 71	0.154

Table 4: Acute Medical Complications.

Medical Complications	**ArTHA**	**TrTHA**
Cardiac	1/11	3/34
Gastrointestinal	0/11	1/34
Infection	5/11	13/34
Nerve Injury	3/11	0/34
Renal	0/11	3/34
Respiratory	1/11	1/34
Wound Complications	1/11	8/34
>1 Complications	0/11	5/34

Tables 5

Table 5: Reasons for re-revision.

Indications	**ArTHA**	**TrTHA**
Aseptic Loosening	10/26	11/20
Dislocation	6/26	5/20
Infection	7/26	4/20
Implant Failure	2/26	0/20
Periprosthetic Fracture	1/26	0/20

Acknowledgements

The authors would like to thank the Tayside Arthroplasty Audit Group (TAAG) team who has contributed data to this study. The authors are grateful to Dr Weijie Wang for statistical advice and Mr Ian Christie for illustrations.

Conflict of Interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.